LA-UR-12-26109

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Author(s): Vigil, Duane M.
Kuhn, Kevin J.
Moore, Steve S.
Lopez, Orlando P.
Foster, Lynn A.
Greenbank, Michael D.
Tandon, Lav
Dozhier, Nathan G.
Stout, Stephen A.

Intended for: Report

Opening the Plutonium-Beryllium Neutron Sealed-Source RGMA1002-468/67

Duane M. Vigil[1], Kevin J. Kuhn[2], Steve S. Moore[3], Orlando Lopez[3], Lynn Foster[4], Mick Greenbank[5],Lav Tandon[2], Nathan Dozhier[3], and Stephen A. Stout[1]

[1] MET-2: Pit Integrated Technologies
[2] C-AAC: Actinide Analytical Chemistry
[3] NCO-1: Weapon Component Manufacturing
[4] NPI-1: Nuclear Process Infrastructure
[5]IRM-CAS: Communication, Arts, and Services

Los Alamos National Laboratory

9-18-2012

TABLE OF CONTENTS

TABLE OF FIGURES

INTRODUCTION

The Foreign Material Characterization Project requires that PuBe neutron sealed-sources be opened to determine the chemical and physical characteristics of the PuBe materials produced for source manufacture. In order to provide an accurate and thorough evaluation of PuBe materials, the sealed-sources must be opened with care so that all PuBe material is retained in the innermost sealed-source container and free from the transfer of nuclear material previously processed in the glovebox.

This particular sealed-source, RGMA1002-467/68, is 1.17 inches high by 0.78 inches in diameter. The cylindrical outer sealed-source container appears to be a type of stainless steel with a 0.078 inch thick plug inserted into the bottom and roll sealed in place. The bottom of the outer container was rolled under leaving a 0.085 inch high lip. The sealed-source identity was verified prior to disassembly by locating the number ‘468/67’ scribed into the bottom of the outer container (Figure 1).

Figure 1. PuBe neutron sealed-source RGMA1002-468/67 prior to disassembly.

A radiograph (Figure 2) was provided to assist in determining the existence and location of the inner container, the physical dimensions of the inner container, and the thicknesses of both container walls, tops and bottoms. This information was useful in planning the breach of the outer sealed-source container to access the inner container without breaching it.

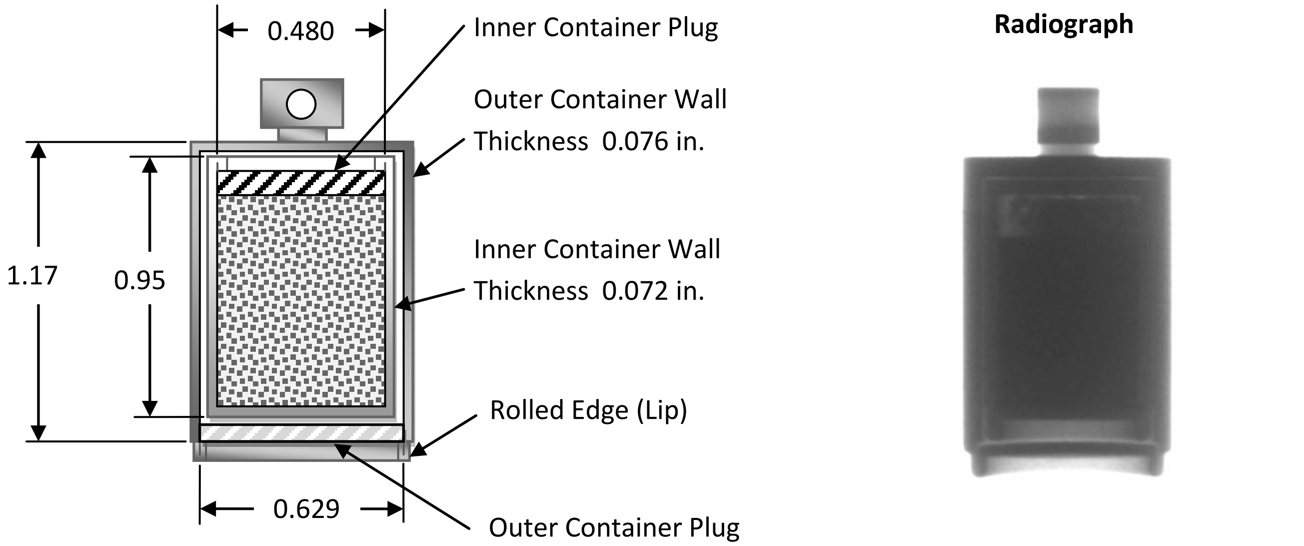

Figure 2. Radiography of RGMA1002-468/67 PuBe neutron sealed-source.

The inner sealed-source container metal type was unknown but exhibited properties during machining that are consistent with stainless steel alloys. No information was available on the construction, fabrication or contents of this container. During the cutting process we discovered the innermost container had a 0.480 inch diameter x 0.078 inch thick plug press fit into the top and roll sealed in place. The container wall thickness was 0.072 inch.

Photographs of the PuBe neutron sealed-source were taken during the opening process from start to finish.

PROCESS

The process of opening PuBe neutron sealed-sources was performed on a manual Hardinge lathe located in GB-384. This method has provided success in opening sealed-sources in the past. A digital camera was used to take photographs and to view magnified images of the sealed-source during the machining process. This provided useful visual details for determining the path forward during sealed-source disassembly.

A 25/32 in. collet was installed in the lathe spindle to hold the outer sealed-source container in place during the opening process. A Kennametal A4G0200M02P02GUP, grooving/turning/cut-off insert was selected for breaching the outer and inner containers. This insert was mounted on a tool holder and attached to the tool post. Prior to disassembly, the dose rate of the source was 20 mrem hr^{-1} beta/gamma at contact with the glovebox glove and 6 mrem hr^{-1} neutron at 30 cm from the source.

After reviewing the radiograph the decision was made to make a cut 0.123 inch (Z) from the bottom of the outer sealed-source container (Figure 3). The top of the outer container was inserted into the collet approximately 0.5 inch and clamped. A spindle speed of 600 rpm was set and manual feed was used by the machinist. (NOTE: The Digital Read Out (DRO) displays insert movement in diametrical terms which is double the actual movement of the cutting insert). The cutting insert was then moved to touch off on the bottom of the outer container and the DRO was set to zero (Z). The same operation was performed on the outer container side wall (X).

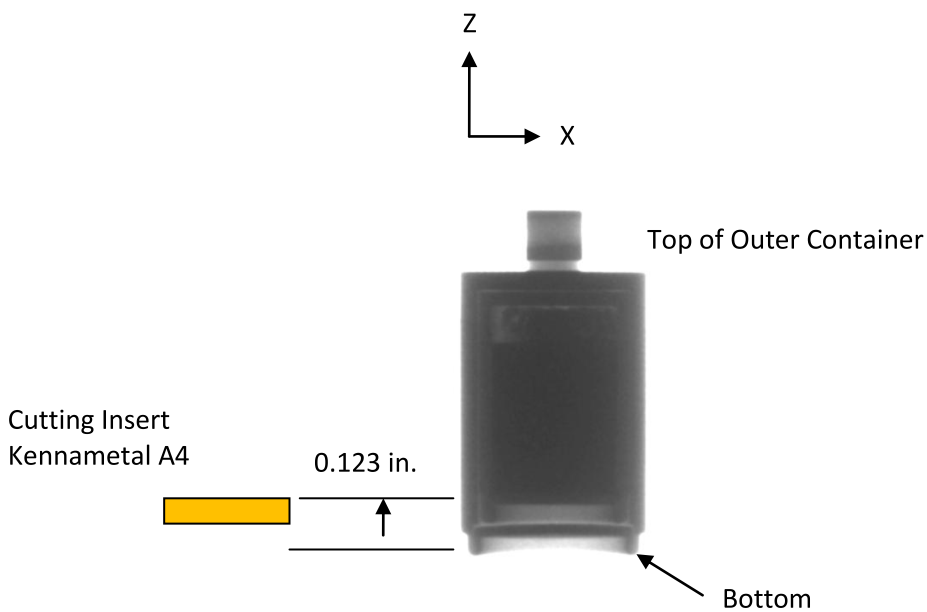

Figure 3. Outer sealed-source container.

As planned for the first cut, the machinist set the cutting insert at 0.123 inch from the bottom of the outer sealed-source container (Z) and began cutting into the container side wall (X) (Figure 3 and 4). He slowly fed the cutting insert manually into the side wall (X) and stopped at 0.107 inch depth for photographs. A decision was made to attempt to pry off the plug after seeing a crack in the cut surface (Figure 5). Holding the container in one hand and using small needle nose vise grips to rock the plug back and forth a few times, the plug began to move. The plug slowly opened and was attached to the container on one side (Figure 6). The end of a solid inner container was evident inside of the outer container (Figure 7). The inner container slid out as the outer container was tipped horizontally (Figure 8).

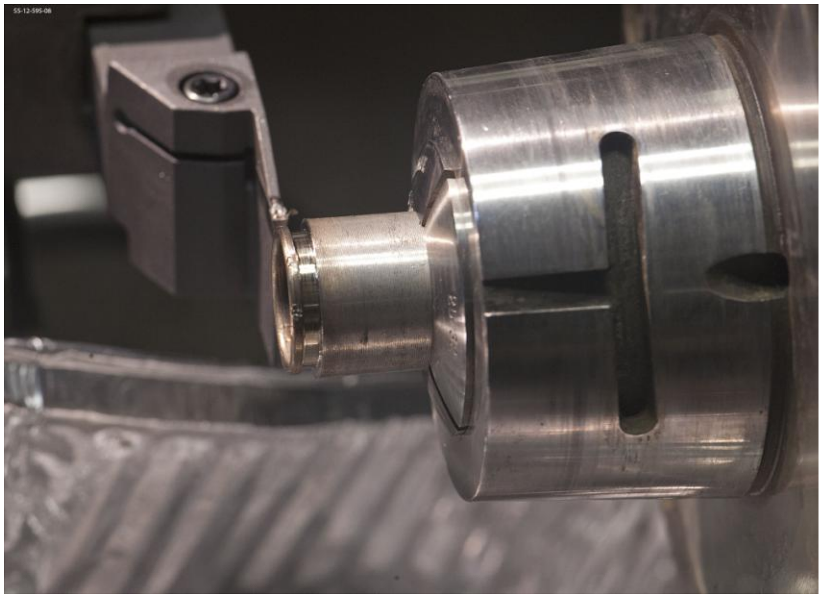

Figure 4. First cut on outer container.

Figure 5. Separation of machined plug visible.

Figure 6. Removal of plug from outer container.

Figure 7. Plug removed from outer container, inner container visible.

Figure 8. Removal of inner container from outer container.

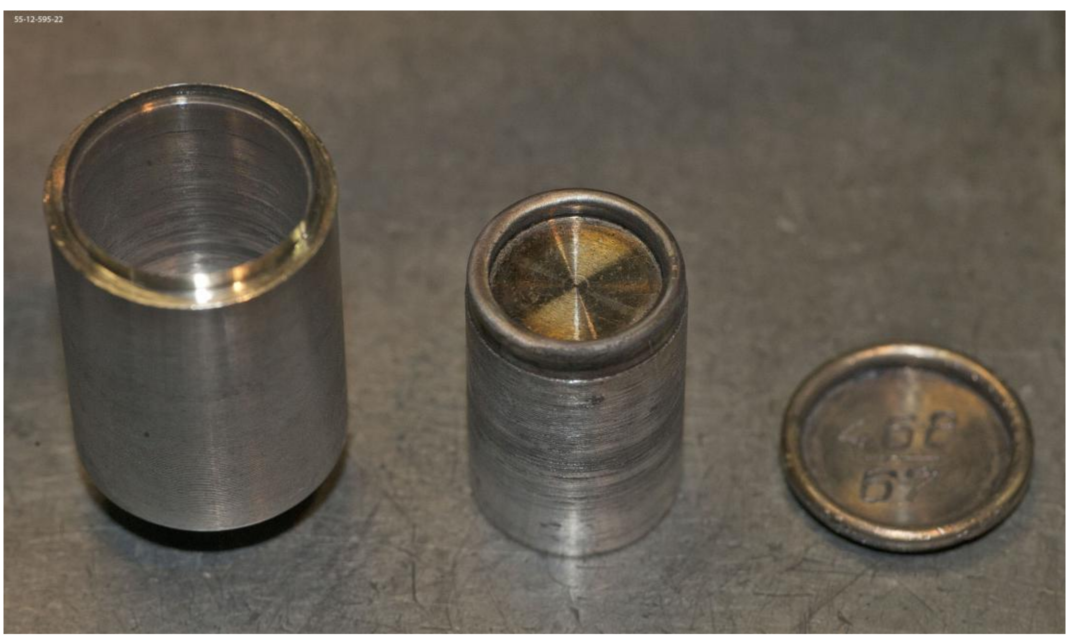

Figure 9. Outer container and inner container.

The sealed-source disassembly to this point is presented in Figure 9. The inner container was examined to determine how to open it to access the PuBe material. The bottom of the inner container was smooth and the top had a plug roll sealed in place. Due to the smaller diameter of the inner container, a 5/8 inch diameter collet was selected and installed on the lathe spindle to hold the container.

The decision was made to set the Z distance at 0.166 inch from the top of the inner container (Figure 10). Concerned that the plug might come out during machining, the tailstock was setup with a live center and pressure pad (Figure 11). The pressure pad was positioned about 0.010 inch from the plug face. Using a new cutting insert, the machinist began cutting into the side of the inner container. After feeding the cutting insert in approximately 0.040 inch (X), photographs were taken (Figure 12) and reviewed on the LCD camera monitor. Machining continued to a cut depth of 0.070 inch (X) and an attempt was made to pry the plug off with the needle nose vise grips by moving it back and forth with very little pressure while held in the collet. The plug moved indicating that the plug was loose. The inner container was removed from the collet and held vertically with one hand while using the needle nose vise grips to pry on the plug. As the plug began to move, it was noticed that the plug was attached to the container on one side. The plug was opened about 45 degrees for photographs but was not removed (Figure 13).

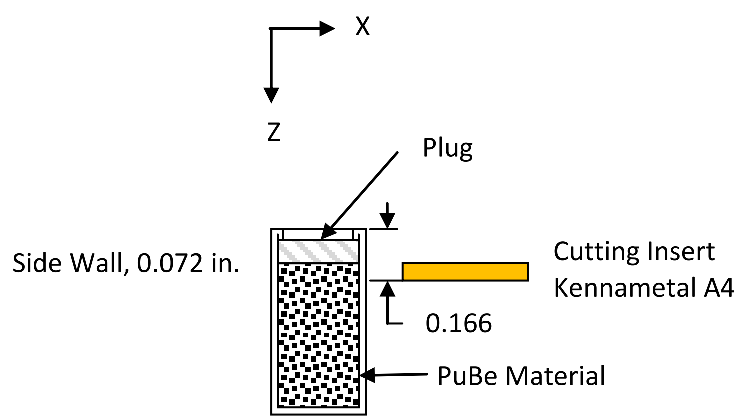

Figure 10. Inner sealed-source container, initial cut.

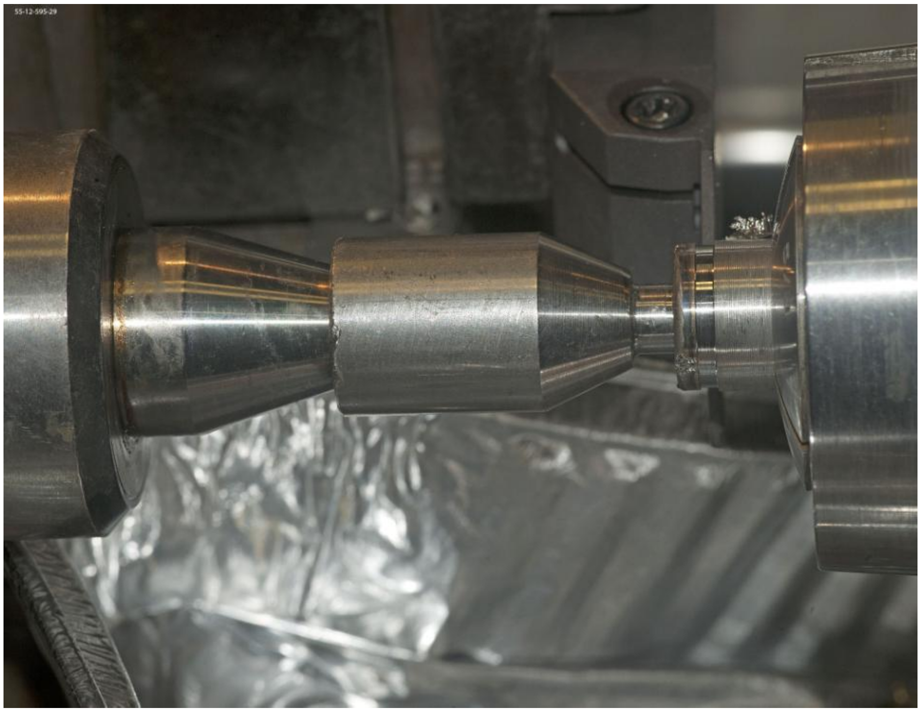

Figure 11. Live center with pressure pad on inner container plug face.

Figure 12. View of inner container and plug interface.

Figure 13. $PuBe_{13}$ material visible in inner container.

Figure 14. Disassembled neutron sealed-source.

After photographs were taken, the plug was replaced and the entire inner container was tightly wrapped in aluminum foil to hold the plug in place and retain PuBe material.

The inner container plug was measured to be 0.48 inch diameter x 0.078 inch length and the wall thickness was approximately 0.072 inch. Figure 14 shows all pieces of the sealed-source following disassembly.

SUMMARY AND CONCLUSIONS

- The radiograph of the PuBe neutron sealed-source was useful in determining dimensions and identifying construction details. This information gives the engineer and machinist a better idea of where to breach the outer container. It would be advantageous to use a higher energy radiography system to provide information about inner container dimensions, construction details, and nuclear material location to facilitate disassembly.

- Characterization of the inner and outer container materials would be useful for selecting proper cutting inserts to provide more efficient and cleaner cuts. A real-time, in-line method for qualitatively identifying metal compositions such as handheld x-ray fluorescent (XRF) may prove sufficient.

- The disassembly of PuBe sealed-sources generally involves numerous attempts to pry a lid or plug from the innermost container. The forces involved make it impractical to hold the source so this attempt must take place with the container held horizontally in the collet. The horizontal orientation risks the flow of PuBe materials out of the container when the plug is freed. To mitigate this risk, it was agreed that a small vise should be introduced into the glovebox to hold the container firmly in a vertical orientation for attempts to pry off lids or plugs. The vise should hold cylindrical containers firmly without inflicting scratches or gouges into sealed-source metal surfaces.

- Documentation of PuBe neutron sealed-source disassembly is effectively recorded with a series of professional photographs as presented in this report. Unfortunately, the prevalence of metal surfaces and materials combined with uneven, low light conditions reduce the contrast between disassembled parts and background. To improve the photographic record of disassembly, colored liner materials should be identified and introduced as a staged background for PuBe component pictures.